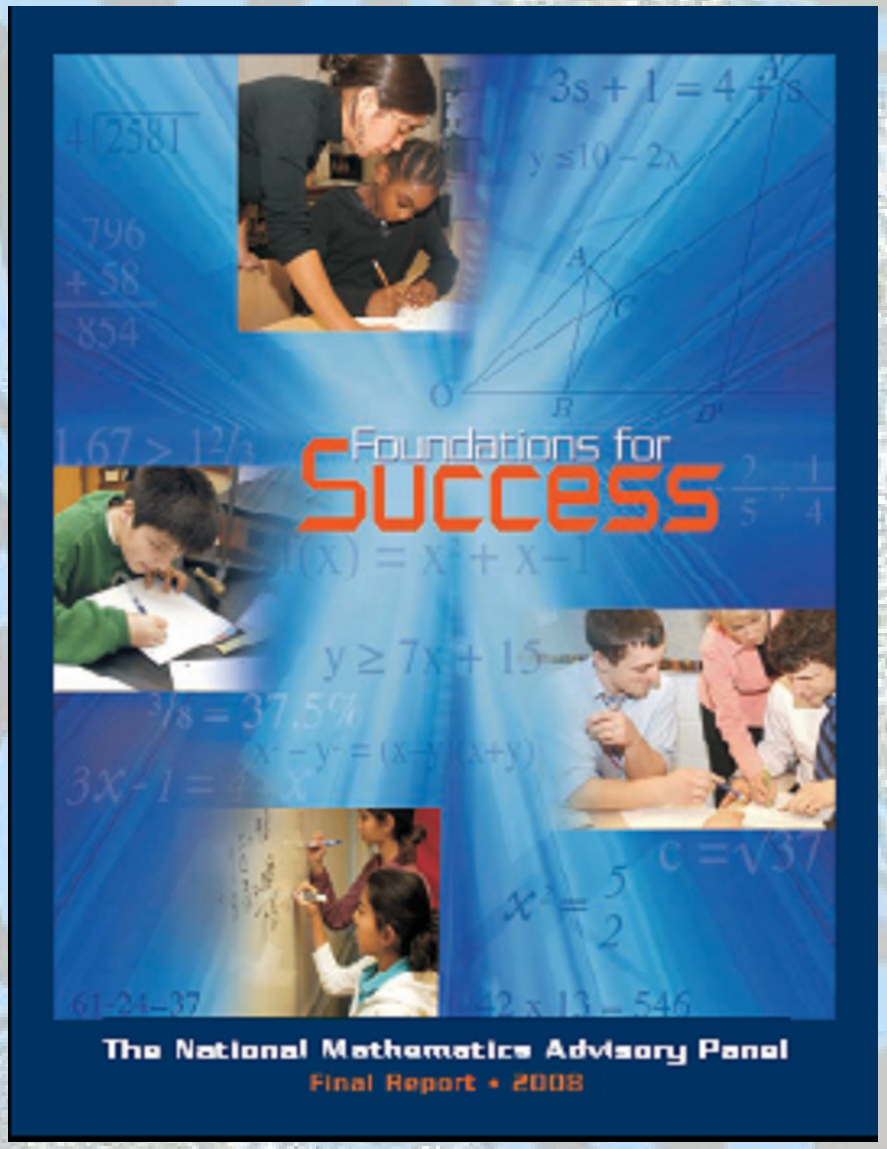
The Beauty of Mathematics

1 x 8 + 1 = 9
12 x 8 + 2 = 98
123 x 8 + 3 = 987
1234 x 8 + 4 = 9876
12345 x 8 + 5 = 98765
123456 x 8 + 6 = 987654
1234567 x 8 + 7 = 9876543
12345678 x 8 + 8 = 98765432
123456789 x 8 + 9 = 987654321

1 x 9 + 2 = 11
12 x 9 + 3 = 111
123 x 9 + 4 = 1111
1234 x 9 + 5 = 11111
12345 x 9 + 6 = 111111
123456 x 9 + 7 = 1111111
1234567 x 9 + 8 = 11111111
12345678 x 9 + 9 = 111111111
123456789 x 9 +10= 1111111111

1 x 1 = 1
11 x 11 = 121
111 x 111 = 12321
1111 x 1111 = 1234321
11111 x 11111 = 123454321
111111 x 111111 = 12345654321
1111111 x 1111111 = 1234567654321
11111111 x 11111111 = 123456787654321
111111111 x 111111111=12345678987654321

The National Math Panel and Utah



What can and should we do based on the national attention in mathematics?

Youth is the Wealth of the Nation

And Utah is very wealthy!

Mathematics Skill is the new Literacy

Opens options for college and career

- Increases prospects for future income.
- Increases probability of college enrollment
- Doubles the likelihood of college graduation

Why do we care about college?

- College graduates are more likely to vote, use new technology, and become civic leaders, and are less likely to be involved in criminal activity (Pascarella & Terenzini, 1991).
- Individuals who receive college degrees earn more and have better career mobility (McGregor, 1994).
- The majority of workers who earn more than $40,000 annually have two or more high school credits at the Algebra II level or higher (Achieve, Inc., 2006).

Narrows the Achievement Gap

- Attending college is a social escalator. It levels opportunities for success across all socioeconomic groups (Pascarella & Terenzini, 1991).
- According to research, “The achievement gap between students of differing ethnic and socioeconomic groups can be significantly reduced or even eliminated if low income and minority students increase their success in high school mathematics and science courses” (Evan et al., 2006, p. 11).

The guiding questions

- What is the essential content of school algebra and what do children need to know before starting to study it?
- What is known from research about how children learn mathematics?
- What is known about the effectiveness of instructional practices and materials?
- How can we best recruit, prepare, and retain effective teachers of mathematics?
- How can we make assessments of mathematical knowledge more accurate and more useful?
- What do practicing teachers of algebra say about the preparation of students whom they receive into their classrooms and about other relevant matters?
- What are the appropriate standards of evidence for the Panel to use in drawing conclusions from the research base?

What is mathematics?

Mathematics is a discipline that enables inductive and deductive problem solving through symbolic reasoning by making connections, proving conjectures, and modeling situations in a dynamic world.

Our goal is competent, creative students who can apply and communicate mathematics with critical understanding.

How did the NMP define Algebra?

Table 1: The Major Topics of School Algebra

Symbols and Expressions
- Polynomial expressions
- Rational expressions
- Arithmetic and finite geometric series

Linear Equations
- Real numbers as points on the number line
- Linear equations and their graphs
- Solving problems with linear equations
- Linear inequalities and their graphs
- Graphing and solving systems of simultaneous linear equations

Quadratic Equations
- Factors and factoring of quadratic polynomials with integer coefficients
- Completing the square in quadratic expressions
- Quadratic formula and factoring of general quadratic polynomials
- Using the quadratic formula to solve equations

Functions
- Linear functions
- Quadratic functions—word problems involving quadratic functions
- Graphs of quadratic functions and completing the square
- Polynomial functions (including graphs of basic functions)
- Simple nonlinear functions (e.g., square and cube root functions; absolute value; rational functions; step functions)
- Rational exponents, radical expressions, and exponential functions
- Logarithmic functions
- Trigonometric functions
- Fitting simple mathematical models to data

Algebra of Polynomials
- Roots and factorization of polynomials
- Complex numbers and operations
- Fundamental theorem of algebra
- Binomial coefficients (and Pascal's Triangle)
- Mathematical induction and the binomial theorem

Combinatorics and Finite Probability
- Combinations and permutations, as applications of the binomial theorem and Pascal's Triangle

Is it a collection of paper and pencil algorithmic skills?

Pre-K through 6th grade curriculum must be streamlined

- **A focused, coherent progression of mathematics learning, with an emphasis on proficiency with key topics, should become the norm in elementary and middle school mathematics curricula. Any approach that continually revisits topics year after year without closure is to be avoided.**

Use of Research on how children learn

- A strong start is critical
- Conceptual understanding, procedural fluency, and automatic recall
- Mathematics literacy is achieved through effort, not just inherent talent

Recognize the essential role of the teacher

Differences in teachers account for 12% to 14% of total variability in students' mathematics achievement gains during an elementary school year

- Need for effective teachers
- Relationship between mathematical content knowledge for teaching and student achievement
- Strengthening teacher education and professional development
- Mathematics teacher specialists
- Salary incentives for recruiting and retaining teachers

Use research on instructional practices

Importance of transition from concrete to abstract

Fractions

Improving Assessment

Formative Assessment

Tell the person next to you three things you see

63

73

Motivation for learning

Real World Problems

Technology

Gifted Students

More research is needed

What is the most critical place for action in Utah right now?